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Williston Lake Fisheries Compensation Program Management Plan

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This report has been approved by the Peace/Williston Fish and Wildlife Compensation Program Fish Technical Committee.

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EXECUTIVE SUMMARY

Williston Lake, the largest body of freshwater in British Columbia, was created in 1968 when the W.A.C. Bennett Dam was completed. Substantial portions of three river systems, the Peace, Parsnip, and Finlay, were flooded, resulting in substantial alterations to fish habitat. In a manner typical for newly-created reservoirs, fish species adapted to the riverine environment declined in abundance, and to some degree have been replaced by species more adapted to the lake-like reservoir environment.

Under the terms of their water licence, B.C. Hydro is obliged to provide compensation for fisheries losses in the Williston Watershed. The goal of this management plan is to provide a guideline for that compensation, through the protection and enhancement of Williston Watershed fish populations and their habitat. The Ministry of Environment is the lead agency overseeing all fisheries management activities. B.C. Hydro will fund the implementation of the plan through a $5 million compensation fund and will also participate at the technical and steering committee levels. The management plan will be available to the general public for comment and input, and the public sector will be kept informed of enhancement activities. Further, organized interest groups will be encouraged to suggest and participate in enhancement projects.

The management plan provides an overview of the physical characteristics of the Williston Watershed, including physiography, climate, vegetation, and soils. A summary of the available hydrological, limnological, and water quality data is also presented.

Recent netting studies (1988) have demonstrated that riverine species such as mountain whitefish, Arctic grayling, and river-resident rainbow trout have all declined since previous investigations (1974-75). Species well adapted to a lacustrine environment, such as burbot and especially kokanee, have shown increases in

relative abundance, as have coarse fish species, such as peamouth chub. Many of the rivers and streams draining into Williston Lake are under-populated with sport species. In particular, Arctic grayling and mountain whitefish, which probably depended on the larger mainstem rivers for adult rearing, have disappeared. Without a suitable forage base in the rivers, the bull trout have apparently moved into the reservoir and now feed primarily on lake whitefish. A major portion of the proposed compensation activities will be in establishing fish populations suited to the altered environment centred on the Williston Reservoir.

The creation of the reservoir provided access to many systems that were previously remote. Angling activity tends to concentrate at river mouths and success rates can be quite good (0.47 fish per hour in the Dunlevy Creek area). As debris problems on the reservoir have improved; so has safe access. While in the Parsnip and Finlay Reaches anglers still target almost exclusively on bull trout, in the Peace Reach, trolling has become more popular and angler effort is split between rainbow trout, bull trout, and kokanee. The majority of angling effort in the watershed, however, concentrates on the numerous smaller lakes and streams and these have become increasingly accessible, largely due to the logging activity. The easy access to a large portion of the watershed has resulted in overfishing in some of the more popular areas.

Management and enhancement activities in this plan are presented in categories based both on macro-habitat type (small lakes, rivers, and streams, Williston Reservoir) and by fish species. These will be highlighted below. The primary effort will always be to maintain or enhance indigenous fish populations. When unoccupied habitat is found, introductions of suitable fish stocks will be undertaken if these will not unduly impinge upon native fish stocks. All enhancement projects will include an evaluation component. Many of the activities will be treated as pilot projects, the results of which will be applied to other systems in the reservoir as the data base expands.

On Williston Lake itself much of the initial effort will be directed towards kokanee. A major constraint on fish production in the reservoir is the large drawdown and the resulting lack of stable littoral environment. Kokanee, being pelagic planktivores, do not depend on the littoral zone and are proven performers in other B.C. reservoirs. Basic biological information needs to be obtained for the current population so that the necessary baseline data is in place to manage this species. A major objective will be to provide an expanded kokanee fishery by introducing stock into tributaries draining into embayments that are accessible to anglers. This should provide a terminal fishery for kokanee as they return to these tributaries to spawn. Additionally, kokanee can be utilized as forage by larger piscivorous species such as bull trout, lake trout, and Gerrard rainbow trout. The possibility of stocking the latter two species will be evaluated with the intent of creating new trophy fisheries in Williston Lake.

The management goal of the small lakes program will be to increase and diversify the angling opportunities in the Williston Watershed. A regular schedule of lake inventories (Recreational Fisheries Branch protocol) will be undertaken, with the objective of identifying enhancement opportunities. Suitable lakes without an existing sport fish population will be considered for stocking. Habitat improvements such as barrier removal, spawning bed improvements, and aeration will be undertaken when practical.

Many of the watershed's rivers and streams were inventoried at the reconnaissance level during 1988 and 1989. The inventory program will continue, providing the necessary background management data. Where habitat and stock protection are inadequate to provide a suitable fishery, stocking programs will be considered. Initial pilot scale river stocking will address two strategies. The first will be to re-establish a river-resident rainbow trout fishery in the Carbon River. The second strategy will be to use several streams as nursery systems where the fish (rainbow trout or kokanee) will recruit to the main lake or embayment fisheries. Evaluations will determine if modifications need to be made to the stocking protocol before expanding to other river systems.

It is apparent, therefore, that for rainbow trout, several strategies will be pursued. Each of these strategies will require unique genetic strains of trout to best utilize the available habitat. Thus, Pennask rainbow trout (or a similar strain) will be used for small lake stocking, Quesnel Blackwater stock will be used in rivers and for embayment program work, while Gerrard rainbow trout will be the choice for the main reservoir and some large lakes where an open-water piscivorous strain is required.

Bull trout are still relatively abundant in the reservoir and, as such, the major effort will be to maintain the indigenous stock. It is apparent that our understanding of the basic life history of bull trout in northern waters is inadequate, and efforts will be made to gather that data.

Protective regulations, such as spawning closures, will be modified as new information becomes available. Long-term monitoring of population dynamics will enable proactive management steps to be taken. Efforts will be made to educate the public on the sensitivity of char populations to angling pressure.

Arctic grayling have all but disappeared from the reservoir, but where populations still exist in some of the major tributaries, every effort will be made to maintain and enhance these populations.

Kokanee have become established in Williston Lake and currently provide a modest fishery. The only confirmed spawning area to date is in the relatively inaccessible Finlay River. It is essential to determine the current distribution of kokanee in the reservoir, and to establish a baseline data set of life-history information for this northerly population. Kokanee will undoubtedly play a central role in Williston Lake fisheries, and will have to be managed intensively. This will require a sound time-series database from which to follow the population dynamics. To facilitate the expansion of the kokanee population into tributaries more accessible to anglers, a stocking program will be initiated utilizing stock from the existing provincial hatchery system. Streams have been, and will be evaluated for their potential as kokanee spawning streams. Creel census and monitoring spawning returns will be used to determine the success of the program.

Lake trout are present in the reservoir in very low numbers and do not currently support a fishery. Due to the large drawdown, lake trout would not be expected to spawn successfully in Williston Lake. However, because Williston Lake has both the forage base and physical characteristics suitable for lake trout rearing, this species should thrive in the reservoir. Although they probably will not reproduce, since lake trout are a long-lived species, they would be available to anglers for a long period. A very modest stocking program could support a trophy fishery, given that success rates should be relatively low. This would provide greater angling diversity in that anglers could anticipate the possibility of catching any one of three large salmonids (lake trout, bull trout, or Gerrard rainbow trout). Initially, a suitable donor stock will have to be identified before any stocking could proceed. After stocking, a low-effort but long-term monitoring program would be undertaken, mostly on specimens creeled or those collected during other routine management activities.

Although this management plan should provide a framework for fisheries management in the Williston Reservoir for at least five years, it is a dynamic plan and will be reviewed regularly as new data is collected and assimilated. Evaluation is a key element and projects will evolve based on early findings. Most importantly, the information and experience gained through implementation of this plan must be clearly documented so as to form the foundation for future plans.

INTRODUCTION

Williston Lake is the largest body of freshwater in British Columbia. It was formed in 1968 by the completion of B.C. Hydro's W.A.C. Bennett Dam. The reservoir has a surface area of 1736 square km and a shoreline perimeter of 1770 km. The Williston Watershed covers an area of approximately 70,000 square km. The construction of the W.A.C. Bennett Dam flooded an enormous amount of riverine habitat and the resultant habitat changes have caused profound changes in fish species composition which are still taking place. Riverine species unable to adapt to the new reservoir environment have declined or disappeared and species more suited to the reservoir have increased.

In 1988, the Williston Lake Fisheries Compensation Program was initiated. This is a joint program, undertaken by the Northern Interior Region of the B.C. Ministry of Environment and B.C. Hydro and Power Authority for the purpose of improving the recreational fisheries opportunities within the watershed, while protecting and preserving the existing stocks. This program is funded through a five million dollar compensation agreement designed to provide long term funding to compensate for the loss of fisheries values caused by the creation of the lake.

Fisheries management in the Williston Watershed, as in the rest of British Columbia, is the responsibility of the Ministry of Environment. Fisheries resources of the watershed will be managed in a manner consistent with Provincial Policy by monitoring the changing fish populations, instituting regulations to prevent the loss of individual stocks, and through enhancement activities. The introduction of new stocks or species may be undertaken in order to make efficient use of the new environment.

B.C. Hydro is to provide funding for the project as per its water licence agreement #27722 and will take an active part in the program at the technical and steering committee levels. The program will inform the public on a yearly basis regarding proposed enhancement activities, seek public opinion as to the direction of the program and encourage participation in the identification and implementation of enhancement projects. In addition, the project will attempt to encourage input and provide employment opportunities for members of the local native community whenever possible.

The purpose of this report is to provide guidelines and criteria for the management of the fisheries resource of the watershed through the joint Ministry of Environment and B.C. Hydro compensation program. It is intended that after a period of five years the program be reviewed and appropriate adjustments be made to the management plan.

GOALS AND OBJECTIVES

The goals and objectives of the Williston Watershed Management Plan are consistent with the provincial fisheries management goal which is to "produce maximum economic, cultural, recreational and scientific benefit for present and future generations of British Columbians". The objectives are also complimentary to the "Fisheries Management Plans Omineca-Peace" and the "Finlay-Omineca Strategic Environmental Plan Technical Report (May 1983)".

The management goal (mission) of the Williston Fisheries Management Program is to protect and enhance the Williston Watershed fish populations and their habitat through the implementation of long term management and enhancement plans. The Williston Fisheries Technical Committee will direct the collection of appropriate fisheries and habitat data and oversee the interpretation of the data for use in the formulation (and reformulation) of management plans.

The objectives of the Williston Lake Fisheries Management Plan are:

a. the conservation and enhancement of existing fish populations through habitat protection, habitat improvements and harvest regulations;
b. maximize fish abundance and species diversity within the constraints of habitat capability;
c. supplement fish populations where appropriate through stocking programs, primarily aimed at the establishment of self-sustaining populations;
d. develop a greater understanding of aquatic ecosystems in northern reservoirs;
e. provide a variety of angling opportunities reflective of public preferences;
f. promote public awareness, appreciation and understanding of fisheries resources and aquatic habitats;
g. involve organized angler associations, environmental interest groups and the general public in fisheries management activities;
h. protect the fisheries resource through effective enforcement of regulations.

GENERAL DESCRIPTION OF THE MANAGEMENT AREA

LOCATION

The Williston Watershed is located in north central British Columbia between 54 and 58 degrees north latitude and 121 and 128 degrees west longitude, occupying an area of 70,860 square km. The watershed is roughly oval shaped, 275 km in width and 525 km in length, with it's southern boundary 40 km north of Prince George (Fig 1).

PHYSIOGRAPHY AND BEDROCK GEOLOGY

The watershed may be divided into three main physiographic zones (Holland 1976): the centrally located Rocky Mountain Trench, the Omineca Mountains to the west and the Rocky Mountains to the east (Fig 2).

In addition the watershed includes portions of the Spatsizi Plateau on the west, the Cassiar Mountains on the north, the Rocky Mountain Foothills on the east, and the Nechako Plateau on the south. The detailed description of the bedrock geology for the watershed is given in "Finlay-Omineca Strategic Environmental Plan Technical Report (May 1983)".

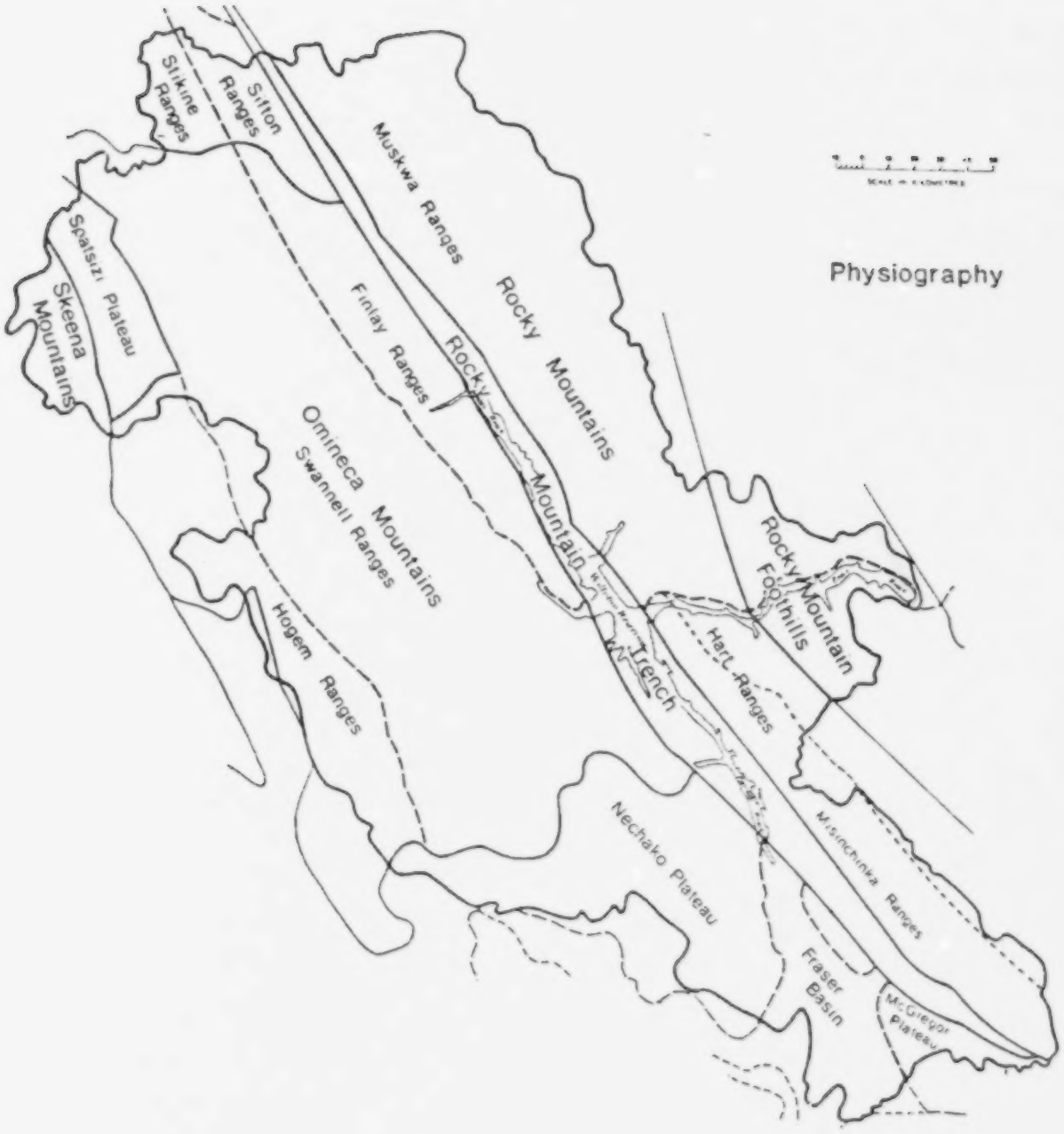
CLIMATE

The Williston Watershed lies within the Continental Subarctic Climactic Zone, dominated by continental air masses and cyclonic storms into which maritime polar air is drawn. This climate is modified by Coastal Ranges to the west which form a barrier against Pacific influences and the Rocky Mountains to the east which tend to protect against winter thrusts of cold polar air from the Northwest Territories. Generally, it is a cold, snow forest climate (humid microthermal) with a cool short summer and a stable but very cold winter. Precipitation is generally light to moderate and evaporation is small; therefore, the climate is moist.

FIG. 1

WILLISTON WATERSHED

FIG.2


Physiography
Sifton Ranges
Skeena Mountains
Spatsizi Plateau
Finlay Ranges
Omineca Mountains
Swannell Ranges
Hogem Ranges
Rocky Mountain Trench
Rocky Mountains
Muskwa Ranges
Rocky Mountain Foothills
Hart Ranges
Nechako Plateau
Fraser Basin
Misinchinka Ranges
McGregor Plateau

Precipitation

Precipitation conditions vary widely across the watershed due to such factors as elevation, latitude, longitude, slope and aspect. A map of mean annual precipitation within the Williston Basin was prepared by the Atmospheric Environment Service on the basis of a variety of information sources, some of which may have a high degree of error. Precipitation information is given in detail in "Finlay-Omineca Strategic Environmental Plan Technical Report (May 1983)".

Temperature

A map of mean annual temperature within the basin was prepared by the Atmospheric Environment Service. This and detail temperature data is contained in "Finlay-Omineca Strategic Environmental Plan Technical Report (May 1983)".

The highest mean values exceed 2°C (in the extreme south) and values over the reservoir generally exceed 0°C. An overall latitudinal decrease of approximately 0.8°C per degree of latitude northwards is suggested, and a loss of temperature of 1.7°C per 300 m increase in elevation is superimposed onto this basic pattern.

The mean monthly values suggest a short cool summer as mean temperatures exceed 10°C for only three months of the year. Extremes of -30°C or colder occur on average for each month from November to March. A temperature of -48°C has been reported for January.

Freeze-up of the Parsnip River (most southerly system) generally occurs in November and breakup is normally in mid April. For the reservoir, freeze up occurs in January or early February and breakup is mid April to early May.

The number of frost free days south of the Peace Reach is estimated to range from 60 to 100 days per year, while north of the Peace Reach, frost free days rarely exceed 60 days.

Wind

Wind information for the watershed is limited. At Mackenzie, the predominant annual wind direction is southerly with a mean speed of 6 km/hour.

The topography of the area causes winds to blow up and down the river valleys and it is not uncommon to encounter strong winds from different directions where valleys meet the main reservoir.

In estimating maximum potential wave heights for the reservoir, fetch is the limiting factor in the Finlay and Parsnip Reaches, and topography the limiting factor in the Peace Reach. Maximum wave heights would be expected to reach 2.7 - 4.2 m on the Finlay and Parsnip Reaches and 2.0 m on the Peace Reach. In general, wave heights greater than 1.5 m would occur less than 3.6% of the time and would usually occur in spring and late fall (Rose 1976). Local experience indicates severe wind and wave conditions can arise with little or no warning at any time and may continue for several days.

SOILS

The basic soil types of the watershed are dystric brunisols, turbic and static cryosols, humo-ferric podzol's and lithic soils.

A detailed description of soil types is given in the "Finlay-Omineca Strategic Environmental Plan Technical Report (May 1983)".

VEGETATION

Five biogeoclimatic zones are represented in the watershed: the boreal white and black spruce, sub boreal spruce, spruce willow birch, Engelmann spruce-sub alpine fir and alpine tundra. Each biogeoclimatic zone contains several ecosystems which occur on different types of soils. For additional information see: "Finlay-Omineca Strategic Environmental Plan Technical Report (May 1983)".

HYDROGRAPHY

Williston Lake was created by the impoundment of the upper Peace and the lower Parsnip and Finlay Rivers resulting in three distinct reaches (Fig 2). The extensive drainage area includes several major systems including the Parsnip, Nation, Omineca, Ingenika, Finlay, and Ospika Rivers. The total tributary flows average approximately 33,400 c.f.s. (based on 1989 dam outflow records).

HYDROLOGY

The dominating physical feature of the basin is the reservoir itself, the largest body of freshwater in British Columbia. The reservoir has a surface area of 1775 square km at full pond and a shoreline of 1770 km. Seasonal water level fluctuations of approximately 17 m occur below the full pool elevations of 672 m (Fig 3). This may be extended to approximately 30 m (the full extent of the water licence) in the future. Full pool is normally reached by mid summer, however, depending on rainfall, snow pack and hydroelectric demand the reservoir may not reach full pool every year.

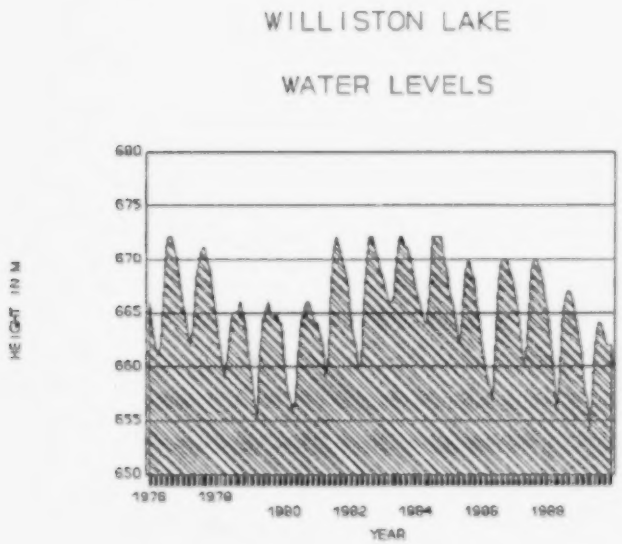


Figure 3

Minimum water levels occur in late winter or early spring. This cyclic variation in water levels, combined with the action of ice and debris scouring, has resulted in a severe, if not total, loss of littoral production, increased bank erosion and a reduction in the spawning success for many species.

The Williston Watershed contains more than half of the small lakes in the Omineca Sub-Region, almost half of the rivers, but is under represented in terms of medium lakes . The lakes have been arbitrarily divided into three size categories according to surface area: large lakes (>1000 ha); medium lakes (>100 & <1000 ha); and small lakes (<100 ha). The Omineca Fisheries Management Statements identifies 20 large lakes, 91 medium lakes, and 2547 small lakes within the watershed.

The rivers have been arbitrarily divided according to their drainage areas: major rivers (over 1500 square km); large rivers (400 - 1500 square km); medium rivers (50 - 400 square km); and small rivers (less than 50 square km). According to Bruce and Starr (1985) there are 262 small rivers, 49 medium rivers, 7 large rivers and 10 major river systems in the watershed. Table I breaks down the number of small, medium, large and major river systems by basin.

TABLE I WILLISTON LAKE TRIBUTARY STREAMS
(Number by Basin)

BASIN	SMALL	MEDIUM	LARGE	MAJOR	TOTAL
PARSNIP	105	19	1	6	131
FINLAY	53	17	2	4	77
PEACE	104	13	4	0	121
TOTAL	262	49	7	10	329

LIMNOLOGY AND WATER QUALITY

Williston Lake

Williston Reservoir reached full pondage for the first time during the summer of 1972. The rapid flushing rate (estimated at 2.2 years for Williston Reservoir) and cyclical drawdown of water levels associated with hydro-electric generation result in reservoirs, such as Williston, having characteristics different from "typical" lakes. B.C. Research studies (1975, 1977) of the reservoir limnology found water quality of moderate hardness at all depths throughout the year. The thermocline was poorly developed in summer, and winter temperatures were marginally above 0°C at all depths. Dissolved oxygen levels were uniformly high and close to saturation at all depths. The influence of the high flushing rate has been clearly instrumental in this regard and also with respect to temperature, which is uniform during winter. Nitrogen and phosphorus concentrations have been shown to be very low and well within the lower range of values associated with an oligotrophic lake. Little seasonal variation in nutrient levels has been recorded, nor have differences been found at depths or throughout the various regions of the reservoir. No evidence has been found to indicate internal nutrient loadings; apparently the near orthograde oxygen distribution is limiting nutrient releases from the sediments.
In summary, although water quality in the reservoir is high, nutrient levels have declined since its creation in the late 1960's, and fisheries productivity is low. In total, Williston Reservoir has exhibited a classic post-impoundment pattern of high initial productivity followed by a prolonged period of decline, which may still be continuing. However, the most significant decreases in Williston productivity have probably already occurred since flooding took place in 1968.

Additional studies were carried out in 1988 to examine water quality parameters and productivity indices of Williston Lake (Fleming and Pulfer, 1988) and to give a comparison to the findings of the 1975 and 1977 studies. Physical and chemical measurements confirmed previous results of high oxygen and weakly developed summer thermoclines with water temperatures ranging from 15°C (surface) to 4°C (bottom).

Intense wind-generated mixing of the water column in portions of the Finlay and Parsnip Reaches is probably a greater influence on water temperature regimes in these two areas than reservoir operation. Wind generated mixing and subsequent delayed ice formation is potentially responsible for the low water temperatures. However, low water levels would exacerbate the rate and extent of water column mixing. The Peace Reach (due to its non-continuous west-east direction, narrow valley, extreme depths and proximity to Bennett Dam) is less affected by water column mixing and more highly influenced by flow-through effects from the low-level water withdrawal.

Nutrient levels and productivity indices examined in 1988 confirmed the oligotrophic status and relative overall productivity and biological activity of the lake system (Table 2).

Water samples taken in the lake during 1988, revealed that copper and chromium levels exceeded Canadian water quality guidelines for the protection of aquatic life (Environment Canada 1987). Copper levels were marginally high and are not considered a problem. Chromium levels, however, regularly exceeded acceptable limits for both fish (0.02 mg/l) and some of the more highly susceptible aquatic communities constituents (0.002 mg/l).

Shoreline erosion, which was extensive following the original flooding, is now limited to specific areas but may limit production in those areas. Mechanisms of the effects on productivity include the reduction of light penetration and the covering of the bottom substrate with sediments.

The large expanses of submerged standing timber, which cover much of the reservoir bottom, provide cover for fish in some parts of the lake, while having an unknown affect on water quality, nutrient exchange and turnover, water flow patterns and productivity in general.

TABLE 2

Chemical and nutrient analyses of Williston Lake as well as a few selective tests. At Finlay Forks, ES.
Values given in mg/l.

Date	13 June 1988				20 August 1988				23 October 1988			
Depth	1	5	20	87	1	5	20	80	1	5	20	85
calcium	23.2	22.2	22.1	26.4	23.9	22.8	26.7	32.8	25.5	29.4	29.3	30.2
cadmium	<0.003	<0.003	<0.003	<0.003	<0.0005	<0.0005	<0.0005	<0.0005	<0.01	<0.01	<0.01	<0.01
cobalt	<0.002	<0.002	<0.002	<0.002	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
chromium					<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.03	0.08
copper	<0.002	<0.002	<0.002	<0.002	0.002	.002	0.001	0.002	0.002	0.001	0.002	0.003
iron	0.213	0.131	0.114	0.086	0.13	0.11	0.07	0.09	0.14	0.07	0.07	0.08
lead	<0.020	<0.020	<0.020	<0.020	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
magnesium	3.72	4.00	4.30	6.62	4.56	4.79	5.23	6.65	5.46	5.43	5.47	5.61
manganese	0.014	0.012	0.013	0.012	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
molybdenum					0.02	0.02	0.02	0.02	0.02	<0.01	<0.01	0.01
nickel					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
vanadium					<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
zinc	0.003	0.002	0.003	0.002	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01	0.01
carbon org	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
carbon inorg	16	17	18	23	16	16	18	21	19	20	20	20
carbon tot	17	18	18	23	16	16	18	21	19	20	20	20
nitrogen org					0.07	0.06	0.08	0.05	0.12	0.07	0.08	0.05
nitrogen kjel	0.25	0.29	0.17	0.42	0.08	0.07	0.08	0.05	0.13	0.08	0.09	0.06
nitrogen tot	0.35	0.37	0.24	0.45	<0.10	<0.09	0.13	0.10	0.16	0.11	0.12	0.12
nitrogen amm	0.30	0.24	0.22	0.09	0.006	0.006	<0.005	<0.005	0.007	0.008	0.009	0.006
nitr. NO3&NO2					<0.02	<0.02	0.05	0.05	0.03	0.03	0.03	0.06
nitrogen NO3	0.10	0.08	0.07	0.03	<0.02	<0.02	0.05	0.05	0.03	0.03	0.03	0.06
nitrogen NO2					<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
phosphorus ort	<0.01	<0.01	<0.01	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	0.003	<0.003	<0.003
phosphorus tot	0.012	0.009	0.007	0.033	0.005	0.005	0.004	0.004	0.004	0.004	0.003	0.003
phosphorus dis	<0.005	<0.005	<0.005	<0.005	0.003	0.003	0.003	0.003	<0.003	0.004	<0.003	<0.003
residue tot					92	98	102	114	100	94	96	107
residue nonfilt					<1	1	<1	<1	1	2	1	1
residue filt					92	97	102	114	99	92	95	106
sp conduct *	118	123	130	165	152	155	164	197	172	172	172	189
turbidity #	2.7	2.0	2.0	8.3	0.9	1.1	0.7	0.5	1.2	1.2	1.2	1.0
hardness					78.5	76.7	88.2	109	86.2	95.8	95.7	98.5

*units: us/cm
#units: ntu

Rivers

Water samples collected on 35 rivers in 1975 (Bruce and Starr 1985) indicate that water chemistry was highly variable with: Specific Conductance (uohm/cm) 24 to 339; Total Dissolved Solids (ppm) 26 to 202; Total Alkalinity (ppm) 8.5 to 165; Dissolved NO2 (ppm) constant at .005; Dissolved NO3N (ppm) <.02 to .07; Total Phosphorous (ppm) <.003 to .019; and Organic Carbon (ppm) <1 to 10. In general, the data indicates the primary difference between the sampled streams is in total dissolved solids (TDS). Turbidity and dissolved nutrients (phosphorous, nitrates, organic carbon) are low for all streams. Streams with the lowest TDS values were located on the west side of the Parsnip Reach while the highest values were found in streams on the west side of the Finlay Reach.

FISHERIES RESOURCES OF THE WILLISTON BASIN

The Williston Watershed contains more than half of the Omineca sub-regions small lakes, almost half of it's rivers and streams but has few medium lakes. The Omineca Fisheries Management Statement estimates a 1990 harvest of 297,600 fish for the Williston Watershed including the portion in the Peace sub-region.

Extensive studies were conducted in 1974-75 on Williston Lake (Barrett and Halsey 1985) and its tributaries (Bruce and Starr 1985). Changes caused by the reservoir and the expected change in species composition and relative abundance make it necessary to update information before embarking on a major enhancement program.

CURRENT STATUS IN THE LAKE

The information gathered during the 1988 gillnetting and 1989 inventory programs confirmed major changes since the 1974-75 studies (Table 3). Species composition and relative abundance has changed to favour species adapted to the lacustrine (lake) environment. Species adapted to the former fluvial environment and dependant upon insects as a prime food source have declined significantly.

Table 3

Changes in Relative Abundance of Williston Lake Fish Species between 1974-75 and 1988

Species	1974-75*		1988	
	No.	%	No.	%
Rainbow trout	426	7.6	134	3.0
Bull trout (Dolly Varden)	150	2.6	202	5.8
Lake trout	0	0	4	0.1
Arctic grayling	106	1.9	2	0.1
Kokanee	4	0.1	79	2.3
Mountain whitefish	660	12.0	19	0.5
Lake whitefish	2720	48.0	1698	48.9
Burbot (ling)	8	0.1	37	1.1
Northern squawfish	97	1.7	48	1.4
Longnose sucker	792	14.2	338	9.8
Largescale sucker	118	2.1	57	1.6
White sucker	3	0.1	16	0.5
Peamouth chub	486	8.7	831	24.0
Redside shiner	3	0.1	1	0.1

% sports fish 1974-75 = 24.2 %
1988 = 13.8 %

* (from Barrett and Halsey 1985; adjusted to include only sites used in the 1988 studies.)

Lake whitefish were still the dominant species caught by gillnet in 1988 (49% of the catch), however, the fish were smaller than in 1974-75. The mean fork length of three year old lake whitefish sampled in 1988 is approximately 50 mm less (300 mm) than fish of comparable age sampled during 1974-75, while four or five year old fish were nearly 100 mm less, (310 vs 410 mm). There was no change in total relative abundance from 1974-75 but changes have occurred in distribution. There has been a decline from 53% to 37% in the Parsnip Reach and a corresponding increase from 34% to 58% in the Finlay Reach. Catch per unit effort (fall netting) for lake whitefish was highest in the Finlay Reach (2.7 fish/net hour) and lowest in the Parsnip Reach (1.7 fish/net hour) but the results were extremely variable ranging from 5 to 0.4 fish/net hour. The lake whitefish utilizing the pelagic area of the lake have significantly greater fork lengths and lower condition factors than the fish utilizing the near shore areas.

The age class distributions have not changed but it appears that the 1974-75 and 1988 studies may have underestimated the ages of the older fish. There is very little growth after the fish reach 300 mm and the literature suggests that aging this type of population using scale data can give under estimates of age.

The concept of a commercial fishery for lake whitefish has been considered, but the fish are currently too small to be marketable (Blackman and Jesson 1990). Further incidental catches of sports species would be unacceptable, as it would not be possible for the fishery to discriminate between whitefish and kokanee. Kokanee, as detailed below, will be a major focus of management activities and will play an important role in the sports fishery.

The subject has been extensively investigated and the subject has been dealt with in detail in "Williston Lake 1988 Gillnet Studies" which is in preparation.

Rainbow trout populations have decreased from 7.6% of the net catch in 1974-75 to 3.0% in 1988. Growth rates and age class structures are similar although there are few older fish present in the Peace Reach. The decline appears to be a result of overfishing and habitat degradation. Siltation and flooding of the spawning areas in the lower reaches of rivers, may have reduced recruitment.

Bull trout (Dolly Varden) have increased in relative abundance from 2.6% in 1974-75 to 7.6% of the gillnet catch in 1988. The growth rates are similar but the population has a higher percentage of older individuals. This could be somewhat misleading in that stocks have declined significantly in areas with heavy angling pressure and surveys of the rivers found very low numbers of resident fish. The bull trout numbers in the reservoir, have increased because of their ability to utilize the large numbers of lake whitefish as a food supply. However, the species is vulnerable to overfishing in areas with high angler pressure.

Mountain whitefish have declined from 12% of the catch in 1974-75 to 0.5% in 1988. Mountain whitefish are still present in most of the rivers but in greatly reduced numbers.

Arctic grayling have declined from 1.9% to 0.1%. This species has all but disappeared except in the larger tributaries.

The decline in mountain whitefish and Arctic grayling is in part due to the species pattern of juvenile rearing in small tributaries, with downstream migration to larger systems as the fish grow. This results in the adult fish rearing in large river systems. The large systems have now been replaced by a reservoir which is unsuitable for adult mountain whitefish and Arctic grayling.

Lake trout were not found during the 1974-75 surveys but 4 were caught in 1988 and an additional fish was found in 1989. The fish sampled were healthy, had an average condition factor of 1.12 and had good growth rates. These fish probably have moved into the reservoir from adjacent lakes (ie. Arctic, Nation, Carbon, and the Fishing Lakes of the Finlay River).

Kokanee represented only 0.1% of the gillnet catch in 1974-75 but increased to 2.3% in 1988. The population appears to be expanding. The fish weigh up to 400 grams, with three year old Williston fish averaging 283 mm in fork length, 298 grams in

weight, and with a condition factor of 1.3 (Blackman and Jesson 1990). In comparison, three year old kokanee in Kootenay Lake average 184 mm in fork length, 67 grams in weight, and have a condition factor of 1.07 (Parkinson 1988).

There are reports of kokanee spawning throughout the lake but the only confirmed area to date is the Finlay River, and these fish spawn in late October. The 1989 creel survey (from the Peace Reach) indicates that 20% of the anglers named kokanee as the preferred species and 13% of the fish kept were kokanee.

Northern pike have been found in the upper reaches of the Crooked River (Summit Lake) and there have been confirmed reports from Williston Lake itself. It is believed that these fish have been introduced by parties unknown.

Coarse fish (northern squawfish, longnose, largescale, and white suckers) populations have remained relatively unchanged since the 1974-75 studies. However, peamouth chub have increased from 8.7% to 24% of the total catch, and constitute up to 35% of the total catch in the Parsnip Reach.

CURRENT STATUS OF RIVERS

The stream inventory conducted in 1989 found very low numbers of fish utilizing the streams. The only areas with significant numbers of juveniles were the small tributaries. It is difficult to compare the numbers of fish present with the 1974-75 studies (which looked primarily at distribution) but the numbers appear to be lower in 1989. Snorkel surveys found many streams with fewer than 10 adult fish per km and many reaches contained no bull trout or rainbow trout. Arctic grayling were only observed in one system and mountain whitefish numbers are much lower than in 1974-75. The only exception to this was the Nation River where there were good populations of rainbow trout, mountain whitefish, and Arctic grayling in remote areas removed from access points.

RESOURCE BASE

The Omineca Fisheries Management statement has identified 20 large lakes (>1000 ha), 91 medium lakes (100-1000 ha), and 2,547 small lakes(<100 ha) within the watershed. Bruce and Starr (1985) identified 262 small rivers, 49 medium rivers, 7 large rivers, and 10 major river systems with a total mainstem length of over 3000 km in the watershed. There is limited information on estimates of production and harvest from these areas. The Omineca Fisheries Management statement projected a harvest of 297,000 fish from the watershed for 1990 and estimates a maximum sustainable harvest of 483,000 fish per year. These numbers were generated from the 1985 National Survey of Sportsfishing in Canada and undoubtably overestimate the actual sustainable harvest for Williston Watershed. They are, however, useful as a relative measure of yield and harvest.

Barrett and Halsey (1985) predicted a sustained sportsfish yield of 0.49 kg/ha/year for the lake. This would translate to approximately 77,000 kg per year. This estimate may be optimistic taking into account the lack of littoral production, due to lake drawdown, and the short growing season.

Hydro-acoustic studies were conducted in conjunction with a gillnetting program in 1988. Results from this study are still under review. The preliminary analysis found, 5 million fish during the spring, 11 million in the summer, and 7 million during the fall. However, the breakdown into species or size groups has not yet been adequately compiled. The relevance of the study to near shore and littoral species has not yet been established, however, it is suspected that the population estimates do not include a high percentage of these populations.

The size and remoteness of this watershed and the changes taking place in the species composition, because of the creation of the reservoir, makes estimating present production and predicting future production highly speculative at best. Future supplies of fish will be in part determined by the success of the enhancement program.

ANGLING PATTERNS

Historically, before the dam, angling was concentrated in the main rivers (Peace, Finlay and Parsnip) near the mouths of major tributary streams such as the Carbon, Clearwater, Nation, Manson, Davis and Chowika. Fishing was exceptionally good for species such as rainbow trout, Arctic grayling and mountain whitefish. Bull trout were caught in moderate numbers as well.

The present angling pattern still tends to concentrate near stream mouths but a moderate amount of effort is devoted to lake fishing in the Peace Reach. Much of the lake fishery involves overnight trips and there are numerous developed and undeveloped campsites at the stream mouths. The use of small boats is restricted to embayment areas because of the tendency for sudden and violent storms on the main lake.

The fishery in the Peace Reach is divided between rivermouth fisheries and trolling in the lake. Species preferred by anglers are rainbow trout (54%), bull trout (23%), and kokanee (20%). There is also a winter ice fishery near the Bennett Dam that produces a harvest near that of the summer fishery in the Peace Reach.

The fisheries in the Parsnip and Finlay Reaches are primarily directed at rivermouths with 91% of the anglers interviewed listing bull trout as the preferred species.

Angling in the many lakes within the watershed is very popular and there are several rivers with good road access. Some of these have been overfished and angling pressure has decreased because of low success. Logging, tree planting, mining and road construction camps are scattered throughout the watershed and fishing pressure near these facilities can be high.

The clearing of debris from the lake and the rapidly expanding road system has greatly improved access to most of the watershed, creating management problems with overfishing in some of the most popular areas.

ANGLER EFFORT AND SUCCESS

The historically dangerous nature of navigating on this reservoir has resulted in limited angler use of the lake itself, and a major portion of the angling effort has concentrated on small lakes and rivers within the watershed.

A creel survey of Williston Lake anglers, consisting of weekly overflights and two access based surveys was conducted in 1989 between May 24th and September 4th. Multiplying the number of boats observed during the overflights by the number of anglers per party, as determined from the access surveys, a total of 3000 angler days were estimated for Williston Lake. The catch per unit effort was 0.47 fish per angler hour or 2.6/day from Dunlevy and 0.29 fish per angler hour or 1.6/day from Finlay Forks.

During the winter of 1989-90 a creel survey was conducted on the ice fishery located near the dam. This information will be collated and available in 1990.

No recent survey information is available for the effort spent on the rivers or small lakes within the watershed. According to the Omineca Fisheries Management Statement (1983), anglers spent 141,000 days fishing the watershed during 1980 or about 25% of the total angling effort in the Omineca-Peace Region for that year.

The above discussion has been restricted to sportfishing. The Native food fishery is an important supplement to the Native sustenance diet. At present, netting permits are issued by the Federal Department of Fisheries and Oceans on the recommendation of the Recreational Fisheries Branch. However, reports of effort and catch are not required under these permits. As a result, the Recreational Fisheries Branch is aware that a considerable amount of netting takes place on a number of lakes, but has little information about the magnitude of this activity or the locations involved. However, it is suspected that in some of the lakes and rivers the native sustenance catch far exceeds the sports fishery and may well exceed the natural productive capability of the system.

PROJECTED ANGLING ACTIVITY

The Omineca Fisheries Statement forecasts 198,000 angler days will be spent in the watershed in 1990, a 40.6% increase over the estimated 141,000 in 1980. Using a success rate of 1.5 fish per day as an objective for 1990, and a 1980 success rate of 0.92, the watershed will be required to provide 298,000 fish, a 230% increase over the 1980 harvest.

The maximum sustainable yield is 1.6 times the target harvest. However, since much of the watershed is inaccessible to anglers, this apparent surplus likely translates to a shortfall in some of the more accessible areas.

If the enhancement program is successful in increasing kokanee populations, an increase in angler activity would be expected in response to this new fishery. In addition, programs dealing with lake trout and Gerrard rainbow trout will stimulate a marked response from anglers seeking "trophy fisheries". The program dealing with small lakes and embayment fisheries should also increase angler success and effort.

WILLISTON WATERSHED MANAGEMENT STRATEGIES

In order to enhance the sportfish stocks of Williston Watershed the factors that are limiting production must first be determined. Species distribution, relative abundance, age class distribution, growth rates, condition factors, spawning areas, and migration or movement patterns will be assessed.

The size and complexity of the system and time constraints, make it impossible to investigate all enhancement opportunities during the initial phase of the program. Key systems identified during 1988-89 will be treated as pilot projects and the results of enhancement activities will be carefully monitored. The refined enhancement strategies can then be applied to more and more systems as they are identified.

There is a strong demand for action rather than studies in this program and a balance should be set between the two, to meet the expectations of the public while at the same time following sound biological principles. The long term success of the program will be dependant upon evaluating and refining the enhancement programs.

A portion of effort each year will be devoted to investigating new enhancement opportunities. This will be especially important as access and angler patterns change.

The 1988 program found dramatic changes in species composition since the 1974-75 studies (Table 3). The 1989 investigations of the rivers found large areas that were virtually barren.

The intention of this plan is to provide the basis from which management decisions will be made and to indicate general guidelines for the program.

ENHANCEMENT CRITERIA

Enhancements will be evaluated on the basis of: technical and biological feasibility, chance for success, access both for the public and project evaluations (ie. remote areas will be given lower priorities), regional importance, public demand, public involvement, and proposed future development by other agencies.

ENHANCEMENT PHILOSOPHY

No enhancement activities will be undertaken without subsequent evaluations, and projects will be designed to fit into a "pilot" type of program where projects can be undertaken, evaluated and the results applied to other areas of the watershed. This is particularly important because of the size and complexity of the watershed. The project should concentrate on enhancement activities and not spend a disproportionate amount of effort evaluating and conducting inventories.

ENHANCEMENT ACTIVITIES BY HABITAT TYPE

Williston Lake

The most important factor limiting fish production is the drawdown. The water level in spring has been, on average, 17 m lower than the mid-summer level which has severely reduced littoral production. The drawdown also reduces spawning success. This is particularly true for fall lake spawners (ie. lake trout) where the drop in water levels would leave eggs exposed to freezing and result in a total loss. Spring spawners would also be affected. Rising water levels may flood spawning areas in the lower reaches of the streams which will result in siltation and suffocation of eggs deposited in the gravel.

Although drawdown cannot be regulated for fisheries concerns there are some possibilities for habitat improvement. For the most part these would be limited to the numerous embayment areas that could be treated, to a certain extent, as separate systems. Small scale pilot projects will be used to investigate the potential benefits of:

- Log booms and or floating reefs to attract or provide refuge for fish.
- Foreshore planting to re-establish shore vegetation and provide areas of seasonally flooded vegetation.
- Stocking or stream spawning habitat improvements to increase recruitment.
- Stream or embayment fertilization to increase productivity.

In addition, access improvements (boat launches or navigational channels) may be considered.

The primary food source in the lake is plankton. Kokanee, being plankton feeders, will make the most efficient use of this resource. Further, kokanee have become an important sports species in numerous lakes and reservoirs in British Columbia and appear to be very well adapted to reservoir environments. The Williston Lake population has increased since the 1974-75 studies and the fish are of sufficient size to support a limited sportsfishery. Increases in kokanee numbers through a stocking program should result in an overall increase in fish production particularly in

accessible embayment areas. In addition to providing a new sportsfishery, kokanee can be utilized as prey by large predatory species such as bull trout. Additionally, a thriving kokanee population will provide forage for lake trout and Gerrard rainbow trout which can be introduced to compliment the existing bull trout fishery.

Bull trout are still relatively abundant in the lake itself but are harvested primarily when the fish congregate in or near the stream mouths. The small population of lake trout is virtually unexploited primarily because the numbers are low and very few anglers fish in a manner that would catch lake trout (ie. trolling in deep water). If Gerrard rainbow trout introductions and a lake trout stocking program are successful there will be three large piscivorous species in the lake that should form the basis of an entirely new trophy fishery.

Goal:

- maintain or improve and diversify the lake fishery, so that a quality fishery will be available to a greater segment of the angling public.

Objectives:

- develop terminal kokanee fisheries in accessible, sheltered embayment areas.
- increase the forage base for large piscivorous species by increasing the kokanee population.
- develop a trophy fishery for lake trout and Gerrard rainbow trout.
- develop or maintain native rainbow trout fisheries.

Strategies:

- assess population distribution, structure and life history to determine factors limiting production of sportfish species within the watershed.
- institute restrictive regulations as required to prevent reductions in populations.
- provide habitat complexing in selected tributaries and embayments to increase carrying capacity and recruitment.

provide new angling opportunities through enhancement aimed at specific species and to reduce angling pressure on historically high use areas,
provide improvements in angler access to sheltered, intensively managed embayment fisheries.
monitor changes in population distribution, species abundance and catch success so that actions can be taken to prevent declines in specific stocks.

Small Lakes

The small lake program is responsible for identifying enhancement opportunities on "small" lakes within the Williston Lake watershed. A lake with a surface area of less than 100 ha is classified as small. On occasion, medium lakes (surface area between 100-1000 ha) and large lakes (surface area greater than 1000 ha) will be assessed for enhancement potential.

Angler accessibility (present and proposed road access) and proximity to populated centres are two key criteria in the initial selection of lakes to be inventoried. It is anticipated the small lake program will be concentrated in the Omineca subregion, with lakes near Mackenzie receiving the initial attention.

Small lakes will undergo a baseline lake inventory using standardized techniques and will add to the provincial aquatic data base. Inventory reports will be generated as a basis for future assessment and to justify stocking requests from the provincial hatchery system.. At the inventory stage, preliminary enhancement opportunities will be identified. Further assessment will proceed on those lakes with the basic requirements for establishing a fishery.

Enhancement opportunities on small lakes may include stocking, habitat manipulation on the inlets and outlets, lake fertilization, lake aeration and chemical treatment. Improving angler access and recreation site development will also be considered. Potential enhancement projects will be prioritized using the enhancement criteria. Evaluations will follow to determine enhancement success or limitations.

The two main fish species considered for stocking into small lakes are rainbow trout and brook trout. Occasionally, there may be some consideration for the introduction of a more exotic species (eg. Yellowstone cutthroat trout). Brook trout stocking will follow provincial policy, requiring that stocking be into a closed system (ie. a lake with no inlets or outlets).

To date, approximately 142 lakes within the Williston Watershed have baseline inventory and/or assessment data on file. This information will be reviewed and further field assessment conducted on lakes with perceived enhancement potential.

Goal:

- maintain, increase or diversify the present sportfish angling opportunities on small lakes within the Williston Watershed.

Objectives:

- increase or maintain natural production and survivability of native and stocked sportfish species.
- provide the angling public with a diversity of angling experiences and options through regulations and stocking.

Strategies:

- inventory lakes and assess enhancement opportunities.
- improve fish production through habitat enhancement where possible.
- stock lakes identified through the inventory program when appropriate.
- institute regulations as require to protect fish stocks.
- identify areas of concern regarding angler access.
- assess the status of native and stocked fish populations, and to monitor the distribution and level of activity of anglers.

Rivers

Fish production from the rivers in the Williston Watershed appears to be low. This can be attributed to physical factors such as low water temperatures, biological factors such as habitat degradation and social factors, the most important being overfishing.

In 1988, aerial reconnaissance videos were taken of selected streams flowing into Williston Lake. A total of 1561 km from 59 tributaries were taped and now provide a permanent record of stream habitats throughout the watershed. This was used to develop a catalog of biophysical maps and tables summarizing habitat capability.

To date, no major rivers (drainage area greater than 1500 square km), with the exception of the Manson River (drainage area 1530 square km) and the Nation River (drainage area 5880 square km), have been surveyed. Due to time restraints, the enormity of the watershed and an initial desire to inventory a good cross section of river types, effort has been concentrated on smaller systems. A gradual phasing in of additional inventories on large (drainage area 400-1500 square km) and major rivers will occur in the coming field seasons. These systems will require the formulation of significantly different management strategies.

The rivers surveyed will be classified according to their physical and biological characteristics. In addition, basic biological baseline data, will be gathered such as: species composition, distribution, relative abundance, growth rates and age class distribution.

Several of the streams surveyed in 1989 (Carbon in particular) appear to have been overfished to the extent that there are insufficient spawners to seed the stream. Nearly all of the streams surveyed had very little juvenile rearing in the mainstem and snorkel surveys found no juveniles with the exception of mountain whitefish (in very low numbers) in mainstem boulder/riffle habitat. This niche appears to be vacant and may be the result of the nearly total disappearance of Arctic grayling and the severe reductions in the numbers of mountain whitefish. Observations of juvenile rearing preferences indicate that native rainbow trout prefer low velocity areas primarily in tributary streams and some side channels. Juvenile bull trout were most often found in lower velocity areas with a cobble substrate. Numbers of both species were very low in most systems. Initial enhancement projects will be designed so that knowledge gained can be applied to other streams with similar characteristics.

River management programs will be designed to address two basic strategies, either jointly or as separate entities. First, attempts will be made, where possible, to establish specific river fisheries (resident "river" rainbow trout). Secondly, attempts will be made to utilize rivers as nursery rearing areas, with fisheries created in the lake and embayment locations (ie. kokanee, and "lake" strains of rainbow trout). Surveys will indicate factors limiting present production and suggest possible enhancements to increase production. Priorities for developing or re-establishing river fisheries will be based on: angler access, carrying capacity, limiting factors and enhancement potential (fish access improvements, stocking, or habitat improvements such as spawning).

Goals:

- maintain and enhance native stocks of resident and migratory fish.
- increase production through stocking where this will not compromise native stocks.

Objectives:

- inventory and evaluate existing fish populations and habitat in rivers.
- develop and conduct appropriate enhancements to re-establish at least two river fisheries in the first five years.
- develop and conduct appropriate enhancements to establish numerous small embayment fisheries through increased recruitment from streams.

Strategies:

- develop a catalogue of the biophysical features of the streams in the watershed.
- enhance habitat where possible to improve fish production.
- stock fish into underseeded waters, where appropriate.
- institute regulations to protect fish stocks.
- monitor native and stocked fish populations and evaluate angler effort and success.

SPECIES SPECIFIC ACTIVITIES

Bull trout (Dolly Varden)

Bull trout are the predominant sportfish species in Williston Lake, and have increased in relative abundance since 1974. This increase may be the result of the success of bull trout as a predator in a lake habitat with a substantial forage base in both the littoral and pelagic zones. However, it appears that numbers of bull trout in areas with heavy angling pressure have been significantly reduced. This species is basically a slow growing, late maturing fish that appears to concentrate near river mouths.

Bull trout are vulnerable to angling pressure. In order to prevent overfishing, rivermouth fisheries will have to be restricted and catch limits reduced. Additional life history data will be collected in order to better manage this species.

A stocking program for bull trout should be a last resort with angling restrictions and increased enforcement being the preferred management options. Another option will be to divert pressure from these areas by creating alternative fisheries or by manipulating habitat (ie. strategically placed log booms) so that fish will be concentrated in less accessible areas.

A public education program will be initiated to help improve the perception of, and compliance with, restrictive regulations.

Goal:

- maintain and enhance the stocks of native bull trout.

Objectives:

- maintain or improve the trophy aspect of the fishery.
- promote and encourage the concept of catch and release.
- conduct selective stream complexing and habitat manipulation to maximize utilization of habitat.

Strategies:

- assess population distribution, structure and life history to determine factors limiting production.
- apply restrictive regulations as required to prevent reductions in the population.
- provide alternative angling opportunities to reduce angling pressure.
- educate the public re: char biology and promote a catch and release fishery.
- provide habitat improvements to increase the carrying capacity of the habitat.
- monitor changes in abundance to prevent declines in the stock.

Rainbow trout

The native stocks of rainbow trout have seriously declined in recent years. Age and growth data shows very little change since the 1974-75 studies, except for a reduction in the older year classes in the Peace Reach indicating that perhaps the decline in stocks has been the result of overfishing. Reservoir drawdown has probably contributed to the decline by reducing insect production in the littoral zone and by causing egg mortalities in the lower reaches of some streams, through siltation, as the reservoir water levels rise. Additional life history information will be gathered in order to better manage this species.

Rainbow trout are not abundant in the rivers. Most rainbow rearing appears to be associated with the smaller tributaries. Since a stocking program will involve the use of hatchery stocks a great deal of the success of the program will depend on the specific stock of fish used. Two quite different stocks will be required. A river stock that will remain resident in the stream and take advantage of boulder/riffle habitat for rearing, and a lake stock that will use the streams only for spawning and short term rearing. Initial age data indicates that the growth rates of rainbow trout rearing in the lake may be greater than those rearing in the rivers.

It is recommended that all rainbow trout released be uniquely marked in order to determine survival rates, return to the fishery and movement.

Goal:

diversify angling opportunities by enhancing native trout and by stocking trout where appropriate in small lakes, rivers and reservoir.

Rainbow Trout in Small Lakes

Rainbow fisheries in some of the more popular small lakes have declined and in some instances there has been a corresponding increase in coarse fish populations.

Objectives:

- identify access issues and improve the quality of angling in key lakes in the watershed.

Strategies:

- to assess small lakes in the watershed for suitability for stocking, habitat improvements, chemical rehabilitation, recreation site development and access improvement.
- develop stocking and enhancement programs including evaluations.
- evaluate forestry development plans to allow inventory, assessment and specific enhancements to precede access to lakes.
- encourage and support public involvement in small lake enhancements whenever possible.

Rainbow Trout in Williston Lake

There are numerous instances of exceptional trophy fisheries developing in the province using Gerrard rainbow trout. A key factor in the development of a trophy fishery appears to be an abundant source of kokanee as a food supply. These large predatory rainbow trout should provide an excellent trophy fishery in the reservoir and provide an alternative to the bull trout fishery. Furthermore, the numerous embayment areas on Williston Lake may be enhanced to provide improved "native" rainbow trout fisheries.

Objectives:

- develop a self-sustaining run of Gerrard rainbow trout large enough to form the basis for a trophy fishery.
- provide additional sheltered embayment fisheries.

Strategies:

- monitor changes in the kokanee population.
- identify suitable river systems for "Gerrard" spawning.
- stock Gerrard rainbow trout into the appropriate streams after sufficient information is available to predict trends in the kokanee population.
- evaluate key embayments for potential improvements (eg. stocking, log booms, access, foreshore planting).
- carry out improvements in embayments on a pilot project basis and proceed to a wider scale if evaluations indicate projects were successful.
- gather additional baseline data on key embayments.

Rainbow Trout in Rivers

Objectives:

- evaluate stream spawning habitat and where necessary effect improvements to increase egg to fry survival rates of the native rainbow stocks (increase recruitment).
- initially develop at least two quality river fisheries as pilot systems before 1995.
- initially develop at least two pilot spawning systems to increase recruitment to the lake embayments.
- preserve the resident stream fisheries while developing the methodologies to increase the same.

Strategies:

- conduct surveys to determine species distribution, relative abundance, gather life history data, determine physical characteristics that may limit production, and evaluate potential for stream enhancement.

- develop a catalog of streams based on physical characteristics and utilization.
- develop regulations to protect and preserve river stocks.
- implement stream enhancement projects (including public involvement) on a pilot project basis with evaluations so that the information gained can be used on other streams with similar characteristics.
- once pilot enhancement projects have been evaluated, expand the program to include other streams with similar physical characteristics.
- develop a stocking program that will best utilize the physical characteristics of each system.
- implement a marking system so that the survival rates and distribution of stocked fish can be monitored.

Arctic grayling

Arctic grayling stocks have all but disappeared from the lake in the last few years. This species is unsuitable for a reservoir environment particularly with drawdown effects. No effort will be made to enhance this species in the main lake per se. However, if suitable stream habitat can be found, a small pilot project will be undertaken to test the feasibility of creating a river fishery.

Isolated populations of Arctic grayling do exist in some of the larger tributaries to Williston Lake. The fish in these tributaries exist independent of the reservoir. These systems will be identified and the Arctic grayling populations within them monitored and maintained.

Goal:

- preserve or increase Arctic grayling stocks within tributary streams of the watershed.

Objective:

- maintain and enhance the angling opportunities for Arctic grayling in the Williston Watershed.

Strategies:

- determine distribution and relative abundance of Arctic grayling within the watershed.
- gather life history data and determine what factors are limiting Arctic grayling production.
- develop a list of potential enhancement options from literature.
- implement small pilot projects to determine the feasibility of creating an enhanced Arctic grayling fishery.

Kokanee

Kokanee stocks have shown significant increases and should continue to do so for some time to come. However, to speed up this process a stocking plan will be implemented in order to establish runs in suitable streams. The aim of the stocking program will be to create additional embayment and terminal fisheries for adult kokanee. Streams will be evaluated on the basis of: quality and quantity of spawning habitat, access to the spawning areas, spring plankton levels off the mouth of the river, potential for a terminal fishery, angler access and access for stocking and evaluations.

Fry releases using southern stock provide the immediate availability of a large number of eggs from an established brood source, with considerably less cost involved than if a northern stock were used. Finlay Reach streams (where documented wild spawning occurs) have been set aside and will not be stocked. As mentioned previously, these northern stocks spawn in late October compared to an earlier spawning period for the southern stocks.

If evaluations of the stocked kokanee indicate poor survival rates or poor spawning success, then enhancement will shift to the wild northern stocks. Starting in 1990, samples for disease analysis will be taken from wild fish so, if it becomes necessary, the provincial hatchery system can be used to incubate and rear the fry (three years of disease free conditions are required to move eggs into a provincial facility).

Documentation of the numbers and distribution of wild kokanee spawners will be conducted on a yearly basis. An intensive investigation will proceed in the Finlay Reach in the fall of 1990.

Goals:

- maintain and evaluate the distribution and population dynamics of wild kokanee stocks.
- create new embayment or terminal fisheries for kokanee through the implementation of a stocking program.

Objective: Wild stocks

- monitor the expanding wild population of kokanee through intensive investigations, and gather life history data that can be used to better manage the species and to identify potential broodstock sources.

Strategies:

- identify and record river systems supporting wild runs of kokanee.
- set aside river systems where wild stocks are known (eg. Finlay Reach tributaries) and monitor.
- improve access to spawning areas.
- develop a plan to utilize native stocks if hatchery stocked fish do not result in self-sustaining runs.

Objectives: Hatchery Stock

- create additional embayment and terminal kokanee fisheries by supplementing the existing kokanee population through a stocking program.
- develop new self-sustaining runs in more accessible areas.
- develop a kokanee population model applicable to Williston Lake .

Strategies:

- assess and rank tributaries for suitability as kokanee spawning streams.
- spring planting of 400,000 fed fry into four or five streams for four years.
- assess stocking success based on escapements and angler success
- address angler access problems to staging areas if required.

Lake trout

The numbers of lake trout has increased since the 1974-75 studies, but these fish are probably the result of movement into the reservoir from other areas of the watershed. Lake trout should do very well in the reservoir given its deep, cold nature and abundant forage base. Reproduction will be severely restricted because of reservoir drawdown.

Goal:

- establish a highly restrictive trophy fishery by the year 2005.

Objectives:

- following stabilization of kokanee populations, proceed with a limited stocking program.
- monitor stock levels for a period of five years.
- gather life history data.

Strategies:

- gather information on lake trout abundance and life history information through other evaluation programs.
- gather the information required to implement a stocking program including the identification of an appropriate donor stock.

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